Transportation Engineering Test 3

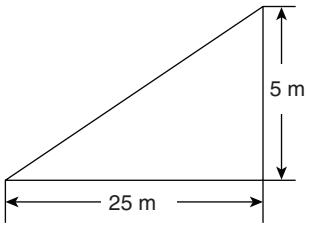
Number of Questions: 30 **Time: 75 min.**

Directions for questions 1 to 30: Select the correct alternative from the given choices.

1. The factors affecting the highway alignment are
(A) Traffic (B) Geometric design
(C) Economy (D) All the above.

2. A test car of mass 1400 N is travelling at a speed of 85 kmph, when it is suddenly braked the wheels. The average vehicles comes to a stop in a distance of 50 m. Skid resisting force is
(A) 7862 N (B) 7928 N
(C) 7804.7 N (D) 7642 N

3. The height and width of the pavement are as given below figure



If $f = 0.15$ and ruling design speed is 60 kmph. Find the absolute minimum radius on the curve in 'm' is _____.
(A) 8.94 m (B) 9.34 m
(C) 6.62 m (D) 7.34 m

4. The turning angle of the curve is 30° and tractive force on the vehicle is 300 N. Then the loss of tractive force due to turning of vehicle in horizontal curve is
(A) 38 N (B) 40 N
(C) 41 N (D) None of these

5. If width of the vehicle is 6 m and height of the vehicle is 10 m and coefficient of friction 0.15 then
(A) Vehicle overturns prior to skidding
(B) Vehicle skids prior to overtaking
(C) Overturning is avoided
(D) Skid is avoided.

6. The design speed of a road is 40 kmph and the radius of curve is 200 m. Then find the length of transition curve for the road of plain and rolling terrain.
(A) 21.6 m (B) 26.1 m
(C) 16.2 m (D) 24.2 m

7. A summit curve is to be designed with two gradients +2% and –6%. The rate of change of gradient is 1% per 100 m length. The minimum radius of curve is.
(A) 100 m (B) 1000 m
(C) 200 m (D) 300 m

8. The material obtained by the destructive distillation of wood is _____.
(A) Bitumen (B) Cutback
(C) Emulsion (D) Tar

9. The mix design of concrete pavement is based on
(A) Flexural strength
(B) Compressive strength
(C) Shear strength
(D) Bond strength

10. The speed at which greatest number of vehicles travel is called
(A) Medium speed (B) Model speed
(C) 15^{th} percentile speed (D) 98^{th} percentile speed

11. A circular curve of radius 300 m, coefficient of lateral friction of 0.15 and the design speed is 40 kmph. The super elevation at which equal pressure is distributed on inner and outer wheel would be
(A) 0.02 (B) 0.06
(C) 0.05 (D) 0.04

12. What will be the non passing sight distance on a highway for a design speed of 100 kmph when its ascending gradient is 2%. Assuming coefficient of friction as 0.7 and brake efficiency is 50%
(A) 176.2 m (B) 174.5 m
(C) 172.3 m (D) 175.05 m

13. A summit curve is formed at the intersection of 3% upgrade and 5% downgrade. What is the length of the summit curve in order to provide a stopping distance of 128 m is
(A) 223 m (B) 248 m
(C) 298 m (D) 300 m

14. Match List - I (traffic survey) with List - II and select the correct answer using the codes given below

	List – I		List – II
a.	Spot speed	1.	By video tape
b.	Traffic volume	2.	By road side interview
c.	O-D survey	3.	By Doppler radar
d.	Parking survey	4.	By pneumatic tube

	a	b	c	d		a	b	c	d
(A)	3	1	2	4	(B)	2	4	3	1
(C)	3	4	2	1	(D)	4	2	1	3

15. What will be the initial traffic after construction, in the Commercial Vehicles per day (CVpd) for following data? Rate of traffic growth per annum = 7%. The road is proposed to be completed in 3 years and present traffic existing is 400 CVpd
(A) 50 (B) 449
(C) 490 (D) 421

16. What is the deflection at the surface of a flexible pavement due to a wheel load of 40 kN and a tyre pressure of 0.5 MPa? The value of ϵ for pavement and sub grade is 20 MPa.

(A) 15 mm (B) 11 mm
(C) 9 mm (D) 6 mm

17. Which one of the following is the set of physical requirements of coarse aggregates for construction of WBM roads as per *IRC* recommendation?

	LAV(%)	AIV(%)	FI(%)
(A)	< 50	< 40	< 15
(B)	< 50	< 30	< 15
(C)	< 40	< 30	< 20
(D)	< 40	< 30	< 15

18. In 500 gm sample of course aggregate are 100 gm of flaky particles and 80 gm elongated particles. What are the flakiness and elongation particles as per Is.
(A) 40% (B) 3.6%
(C) 18% (D) 4%

19. The design speed of a traffic lane is 70 kmph. What is the theoretical capacity per hour taking the total reaction time to be 2 seconds and average length of vehicles as 8 m.
(A) 828 veh/m/day (B) 735 veh/m/day
(C) 628 veh/m/day (D) 428 veh/m/day

20. Consider following factors
1. Length of the vehicle
2. Width of the vehicle
3. Approach speed
4. Stopping time for approaching vehicle
5. Passing sight distance

Which of these factors are taken into consideration for determing yellow time of traffic signal at intersection?
(A) 1, 2 and 5 (B) 2, 3 and 4
(C) 1, 3 and 5 (D) 1, 3 and 4

21. On a road the free speed was 65 kmph and the space headway at jam density was 6.25 m. What is the maximum flow which could be expected on this road?
(A) 2600 vph (B) 1625 vph
(C) 1300 vph (D) 406 vph

22. In marshall method of mix design, the course aggregates, fine aggregates, filler material and bitumen, having respective specific gravities of 2.62, 2.72, 2.70 and 1.02 are mixed in the ratio of 55, 34.6, 4.8 and 5.6 percent respectively. The theoretical specific gravity of mix would be.
(A) 2.36 (B) 2.4
(C) 2.44 (D) 2.5

23. Compute the equalent radius of resisting section of 15 cm slab, if ratio of radius of wheel load distribution to thickness of slab is 0.5
(A) 7.82 cm (B) 7.93 cm
(C) 7.48 cm (D) 7.62 cm

24. The centrifugal ratio of a vehicle is 0.25, width of vehicle is 2.4 m, height of vehicle to its *C.G* is 4.2 m, lateral friction is 0.15, assuming no superlevation.
(A) Lateral skid occurs first
(B) Overturning occurs first
(C) Neither lateral skid nor overturning
(D) Both simultaneously

25. Find minimum sight distance to avoid head on collision of two cars approaching at 90 kmph and 60 kmph. Used reaction time of driver $t = 2.5$ sec, coefficient of longitude friction, $f = 0.7$ and brake efficiency of 50% in either case is.
(A) 235.8 m
(B) 243.2 m
(C) 256.8 m
(D) 292.3 m

26. The last time due to starting delay on a traffic signal approach is noted to be 3 seconds, the actual green time is 20 seconds and amber time is 3 seconds. How much is the effective green time.
(A) 19 sec (B) 22 sec
(C) 27 sec (D) 31 sec

27. The free mean speed on a road wing is found to be 60kmph under stopped condition the average spacing between vehicle is 6 m. The capacity of flow, assuming linear speed density relation is
(A) 2333 veh/hr
(B) 3333 veh/hr
(C) 2870 veh/hr
(D) 3838 veh/hr

28. A road 10 m wide is to deflect through and angle of 65° with the centreline radius 350 m. A transition curve is to be used at each end of a circular curve of such a length that the rate of gain of radial acceleration $0.4\ m^2/sec$, when speed is 60 kmph. Find the shift of the transition curve.
(A) 0.13 m (B) 3.12 m
(C) 0.18 m (D) 3.42 m

29. If the lamp lumen is 30 lux coefficient of utilization is 0.3, maintenance factor is 0.25, average lux on road is 15 and width of road is 7.5
(A) 2 m (B) 3 m
(C) 2.5 m (D) 3.5 m

30. Consider the following statements with reference to pavements
(1) Flexible pavement are more suitable an rigid pavements in regions. Where sub grade strength is uneven
(2) Load carrying capacity of rigid pavements depends more on properties of concrete than strength of sub grade
(3) Compared to flexible pavements, rigid pavements are more affected by temperature variations

Which of these statements are correct.
(A) 1 and 2 (B) 1 and 3
(C) 2 and 3 (D) 3 alone

Answer Keys

1. D	**2.** C	**3.** A	**4.** B	**5.** B	**6.** A	**7.** A	**8.** D	**9.** A	**10.** B
11. B	**12.** D	**13.** C	**14.** B	**15.** C	**16.** D	**17.** D	**18.** A	**19.** B	**20.** D
21. A	**22.** D	**23.** D	**24.** A	**25.** A	**26.** B	**27.** B	**28.** A	**29.** A	**30.** C

Hints and Explanations

2. $\frac{1}{2}mv^2 = (wf) \times d$

$\downarrow$

Skid resistance force

$\therefore$ skid resistance force $= \frac{1}{2}\frac{mv^2}{d}$

$$= \frac{1}{2} \times \frac{(1400) \times \left(85 \times \frac{5}{18}\right)^2}{50}$$

$= 7804.7$ kg Choice (C)

3. $e + f = \frac{V_{min}^2}{gR_{min}}$

$e = \frac{E}{B} = \frac{1}{5} = 0.04$

$$0.04 + 0.15 = \frac{\left(60 \times \frac{5}{18}\right)^2}{9.8 \times R_{min}}$$

$$R_{min} = \frac{\left(60 \times \frac{5}{18}\right)^2}{9.8(0.04 + 0.15)}$$

$= \frac{16.66}{9.8 \times 0.19} = 8.94$ m Choice (A)

4. Loss of tractive force $T(1 - \cos\theta)$

$= 300(1\text{-}\cos 30°) = 40.1$ N Choice (B)

5. $b = 6$ m

$h = 10$ m

$f = 0.15$

$\frac{b}{2h} = \frac{6}{2 \times 10} = 0.3$

$F = 0.15 < \frac{b}{2h}$

$\therefore$ Vehicle skids prior to overtaking Choice (B)

6. $V = 40$ kmph

$R = 200$ m

$L = \frac{2.7 \times 40^2}{200} = 21.6$ m Choice (A)

7. $R = L/N$

$N = g_1 - g_2 = 2 - (-6)$

10 %

$L = \frac{\text{Total change of grade}}{\text{rate of change of grade}} = \frac{10 \times 100}{1} = 1000$

$R = \frac{1000}{10} = 100$ m Choice (A)

11. $e + f = \frac{V^2}{gR}$

For equilibrium super elevation (equal pressure on two wheels) $f = 0$

$e = \frac{V^2}{gR}$

$V = 40$ kmph $= 40 \times \frac{5}{18} = 11.11$ m/s

$\therefore$ $e = \frac{(11.11)^2}{9.8 \times 200} = 0.06$ Choice (B)

12. Non passing sight distance $= vt + \frac{v^2}{2g(f + n)}$

$V = 100$ kmph $= 100 \times \frac{5}{18} = 27.7$ m/s

Non passing sight distance

$$= (27.7 \times 2.5) + \frac{(27.7)^2}{2 \times 9.8(0.7 \times 0.5 + 0.02)}$$

$= 69.25 + 105.8 = 175.05$ m Choice (D)

13. **Deviation angle**

$N = 3 - (-5) = 8\% = 0.8$

Assuming $L > S$

$L = \frac{NS^2}{4.4} = \frac{0.08 \times (128)^2}{4.4} = 298$ m Choice (C)

15. $A = P\left(1 + \frac{r}{100}\right)n$

$P = 400$ commercial veh/day

$r =$ rate of traffic growth $= 7\%$

$n = 3$ years completion time

$A = 400\left(1 + \frac{7}{100}\right)^3 = 490$ cvd Choice (C)

16. Deflection,

$\Delta = \frac{1.5pa}{E_S}$ (for flexible plate)

Where,

$p =$ contact pressure due to wheel load $= 0.5$MPa

a = radius of contact area

$$\text{Contact area} = \frac{\text{Wheel load}}{\text{tyre pressure}} = \frac{40\times10^3\ \text{N}}{0.5\ \text{N/mm}^2}$$

$$= 80 \times 10^3\ \text{mm}^2$$

And area

$$\pi a^2 = 80\times10^3$$

$$A = \sqrt{\frac{80\times10^3}{\pi}} = 159.615\ \text{mm}$$

$$E_s = 250\ \text{MPa}$$

$$\text{So, } \Delta = \frac{1.5\times0.5\times159.617}{20} = 6\ \text{mm}$$ Choice (D)

17. For *WBM* the prescribed value of *LAV*, *AIV* and *FI* for Base course are < 50%, < 40%, and < 15% respectively and Surface course are < 40%, < 30% and < 15% respectively

Where,

LAV is los-angles abrasion value

AIV is aggregate Impact value

FI is flakiness index. Choice (D)

18. $$\text{Flakiness index} = \frac{100}{500}\times100 = 20\%$$

$$\text{Elongated index} = \frac{80}{400}\times100 = 20\%$$

Total = 20 + 20 = 40% Choice (A)

19. Theoretical capacity

$$C = \frac{1000V}{S}$$

$$S = SSD = L = 0.278\ vt + \frac{(0.278v)^2}{2fg} + L$$

$$= (0.278\times 70\times 2) + \frac{(0.278\times70)^2}{2\times0.4\times9.81} + 8 = 95.1736\ \text{m}$$

$$\text{Capacity} = \frac{1000v}{S} = \frac{1000\times70}{95.136}$$

$$= 735.5\ \text{veh/m/day.}$$ Choice (B)

21. $$\text{Jam density} = \frac{1000}{\text{space head way (H)}}$$

$$= \frac{1000}{6.25} = 160\ \text{veh/ km}$$

$$\text{Maximum flow} = \frac{\text{jam density}\times\text{free speed}}{4}$$

$$= \frac{160\times65}{4} = 2600\ \text{vph}$$ Choice (A)

22. Theoretical specific gravity

$$G_t = \frac{100}{\frac{w_1}{G_1}+\frac{w_2}{G_2}+\frac{w_3}{G_3}+\frac{w_4}{G_4}} = \frac{100}{\frac{55}{2.02}+\frac{34.6}{2.72}+\frac{4.8}{2.7}+\frac{5.6}{1.02}}$$

$$= 2.49 \simeq 2.5$$ Choice (D)

23. h = 15 cm, a/h = 0.5

$a = 0.5 \times 15 = 7.5$ cm

$$b = \sqrt{(1.6a^2 + h^2)} - 0.675h$$

$$= \sqrt{(1.6(7.5)^2 + 15^2)} - 0.675(15)$$

$$= 7.62\ \text{cm}$$ Choice (D)

24. $P/w = 0.25$

$b = 2.4$ m

$h = 4.2$ m

$f = 0.15$

$$\frac{P}{W} = \frac{b}{2h} = \frac{v^2}{gR}$$

To avoid overturn $\frac{b}{2h} > \frac{P}{w}$

$$\Rightarrow \frac{2.4}{2\times(4.2)} > 0.25$$

$$0.285 > 0.25$$

To avoid lateral skid $f > \frac{P}{w}$

$$\Rightarrow 0.5 > 0.25$$

$$F < \frac{b}{2h} \Rightarrow 0.15 < 0.285$$

$\Rightarrow$ vehicle skids prior to over turning

$$\frac{b}{2h} < f \Rightarrow 0.285 < 0.15\ \text{C}$$

$\Rightarrow$ vehicle overturns prior to skidding Choice (A)

25. $v_1 = 90$ km/ hr

$v_2 = 60$ km/hr

$t = 2.5$sec

Brake efficiency = 50%

$f = 0.7$

*SSD*1 for first car is = 153.6 m

*SSD*2 for second car is = 82.2 m

SSD = *SSD*1 + *SSD*2 = 235.8 m Choice (A)

26. Effective green time

$$G_e = G + A - L$$

$G = 25$ sec

$A = 3$ sec

L = intinal lost time (L_i) + final lost time (L_f)

$$G_e = 25 + 3 - (3+3) = 22\ \text{sec}$$ Choice (B)

27. Jam density= $\frac{1000}{6}$ = 166.67Veh/km

Maximum flow (or) capacity

$= \left(\frac{80}{2}\right)\left(\frac{166.67}{2}\right) = 3333.33$ veh / hr Choice (B)

28. $R = 350$ m

$V = 60$ kmph = 16.67 m/s

$\propto = 0.4$ m^3/sec

$L_S = \frac{v^3}{cR} = \frac{16.67^3}{2} = 33.07$ m

$S = \frac{L^2}{24R} = \frac{(33.07)^2}{(24 \times 350)} = 0.13$ m Choice (A)

29. Spacing of lamps = $\frac{100 \times 0.3 \times 0.25}{15 \times 7.5} = 2$ m

Choice (A)

30. 2 and 3 Choice (C)